
IBM Tucson: invitation to excellence

How would you like to work on the frontiers of your profession, with some of the best people in your field, on products that define the state of the art in data processing?

How would you like to live year-round in a city nationally recognized to be a vacation paradise—a city with a near-perfect climate, access to the full range of outdoor activities from snow skiing to scuba diving, and a wide selection of entertainment and cultural events?

People who work at IBM in Tucson don't have to choose between profession and lifestyle. They experience the best of both worlds.

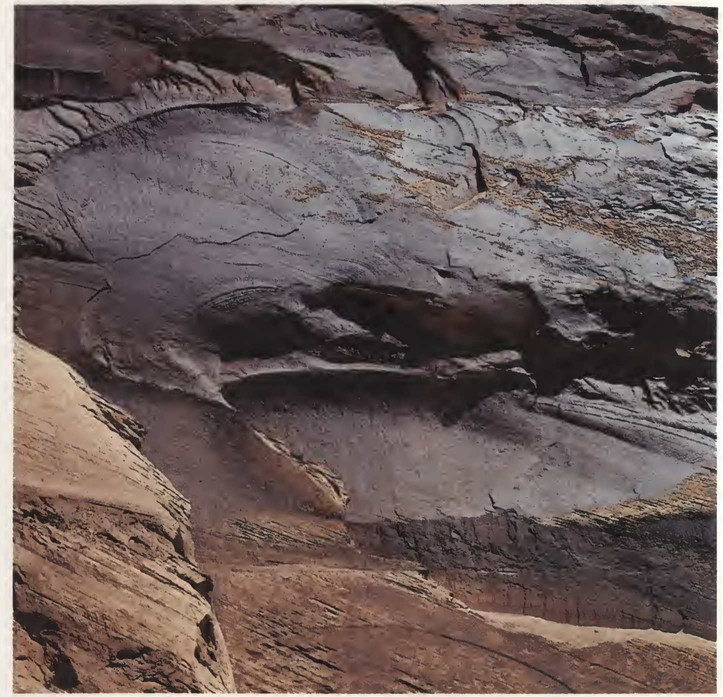
IBM's General Products Division dedicated a brand new manufacturing plant and development laboratory in Tucson in October, 1980.

The site's manufacturing mission includes IBM tape drives, high speed non-impact printers, direct access storage drives, and the IBM Mass Storage Subsystem. It also includes magnetic tape, and the assembly and test of printed circuit cards.

The laboratory has development and product management responsibility for non-impact system printers, library storage systems and flexible media products, including controllers and the magnetic media itself. It also develops software to support those products.

The product test lab serves as IBM's first and most critical customer. It is completely independent of the development laboratory and the manufacturing plant.

The test lab evaluates all of Tucson's products for function, performance characteristics, and adherence to and adequacy of their specifications. Its goal is to provide better, more dependable products for IBM's customers.



IBM realizes that the quality of your working environment is just as important as the quality of the people you work with, the products you work on, and the community you work in.

The plant/laboratory complex in Tucson was designed with that fact in mind.

The tools and instruments you work with, of course, are the finest available. That's taken for granted. Your working environment extends beyond your immediate office or lab, however, and considerable effort has been expended at IBM Tucson to make that environment as pleasing as possible.

General Products Division employees work at two locations in Tucson. The main site occupies 300 of IBM's 1800 acres a few miles southeast of the city. About 40 acres are occupied by the IBM Club Recreation Center, which has facilities for tennis, basketball, volleyball, fields for softball, soccer and football, a par course, and showers and lockers. The facilities are available for use by all employees and their families, at no charge.

Buildings at the main site are connected by a covered walkway that provides shade from the sun in the summer and protection from thundershowers in the rainy season. All site utilities are carried in lines overhead in the walkway to eliminate the need for tearing up the ground for repairs or lab reconfigurations.

The Tucson complex continues IBM's long tradition of social responsibility. The desert landscaping that contributes so much to the beauty of the site includes cacti and shrubbery that occupied the area before construction began. They were removed before groundbreaking and replanted when construction was complete.

Recycled water is used for irrigation, as well as for sanitary flushing and in the evaporative cooling system. A state-of-the-art computer-controlled energy management system helps keep energy consumption to a minimum. Because of these and other features, IBM Tucson has won awards at the local, state and national level for environmental responsibility.

At lunchtime employees are offered a wide selection in the company-subsidized cafeteria.

IBM's art collection is one of the finest in the corporate world, and the works displayed throughout IBM Tucson are a worthy addition to this collection. More than 40 artists are represented, and themes range from Southwestern to abstract expressionism.

The first facility built for IBM in Tucson, located near Tucson International Airport, continues to be used for a number of administrative, development and manufacturing activities. The site consists of five buildings with 550,000 square feet of floor space. The cafeteria at the airport site has an outdoor patio and a landscaped central courtyard that's a popular spot for playing catch during the lunch period.

The following products are the responsibility of IBM Tucson's manufacturing plant and/or its development laboratory.

IBM 3851 Mass Storage Facility—The 3851 is manufactured in Tucson for customers worldwide. Known as a library storage product, it stores information in fist-sized tape cartridges which can hold 50 million bytes each. That's about as much information as is contained in 13 Webster's dictionaries. The cartridges are stored in individual cells in walls of honeycombs. Storage capacity ranges from 35 billion to 472 billion bytes, depending on the user's needs. The MSF forms the heart of the IBM 3850 Mass Storage System, which is designed primarily for users who require high storage capacity.

IBM 3800 Printing Subsystem—The fastest computer printer made by IBM, the 3800 Printing Subsystem can produce high-contrast, quality printouts at rates of up to 20,040 lines a minute. Manufactured in Tucson, the 3800 printer blends laser technology and electrophotography to provide not only speed, but also versatility and economy. The printer accommodates 50 different sizes of standard single-part continuous forms of paper and offers a variety of character sets. Paper races through the 3800 at a constant velocity of 31 inches per second. The 3800 can turn out up to 1.7 miles of paper per hour.

IBM 3310 Direct Access Storage Device—The 3310, which was a combined development effort of the General Products Division's labs in San Jose, California and Hursley, England, was announced with the IBM 4331 processor in 1979. Its four models are available in storage capacities of either 64.5 or 129 megabytes (million characters of information). Up to four strings of two 3310's each may be attached to an IBM 4331 processor, for a maximum 1,032 million bytes of online storage.

IBM 3370/3375 Direct Access Storage Devices—The 3370 and 3375 were announced in 1979 and 1980, respectively, and offer more storage capacity at less cost than IBM's earlier disk storage devices. For example, in a typical operating environment the 3375 stores more than 819 million characters of information, or the equivalent of 655 novels, each 500 pages long. It takes the 3375 an average of 19 thousandths of a second to locate any given bit of information, and it can transfer data at 1.86 million characters per second.

IBM 3880 Storage Control Models 11 and 13—In October 1981 GPD Tucson introduced the first products to be developed and manufactured at IBM's Tucson facilities. By using advanced storage management techniques featured in the new 3880 Storage Control models, the GPD Tucson Laboratory developed a fast and efficient storage hierarchy system designed for compatibility with IBM's large processors and Direct Access Storage Devices.

The primary advanced technique is the high-speed electronic "cache" (storage) built into the new controllers. Data frequently required by the processor is kept in the cache, instead of in the DASD. The Model 11 transfers data from the central processor to the control unit cache at 1.5 or 3.0 million bytes per second. The model 13 transfer rate is 3.0 million bytes per second.

The internal cache of the Model 11 stores 8 million bytes of information, equivalent to more than five issues of The Wall Street Journal. The Model 13 subsystem has a capacity of either 4 or 8 million bytes.

GPD Tucson's laboratory has development responsibility for all of IBM's tape drives, as well as for the magnetic tape itself. In addition, it is responsible for any engineering changes to IBM's current tape products.

Those products include the IBM 8809 Magnetic Tape Unit, manufactured in Fujisawa, Japan; the IBM 3420/3803 Magnetic Tape Subsystem, manufactured in Valencia, Spain; and the IBM 3410/3411 Magnetic Tape Subsystem, manufactured in Tucson.

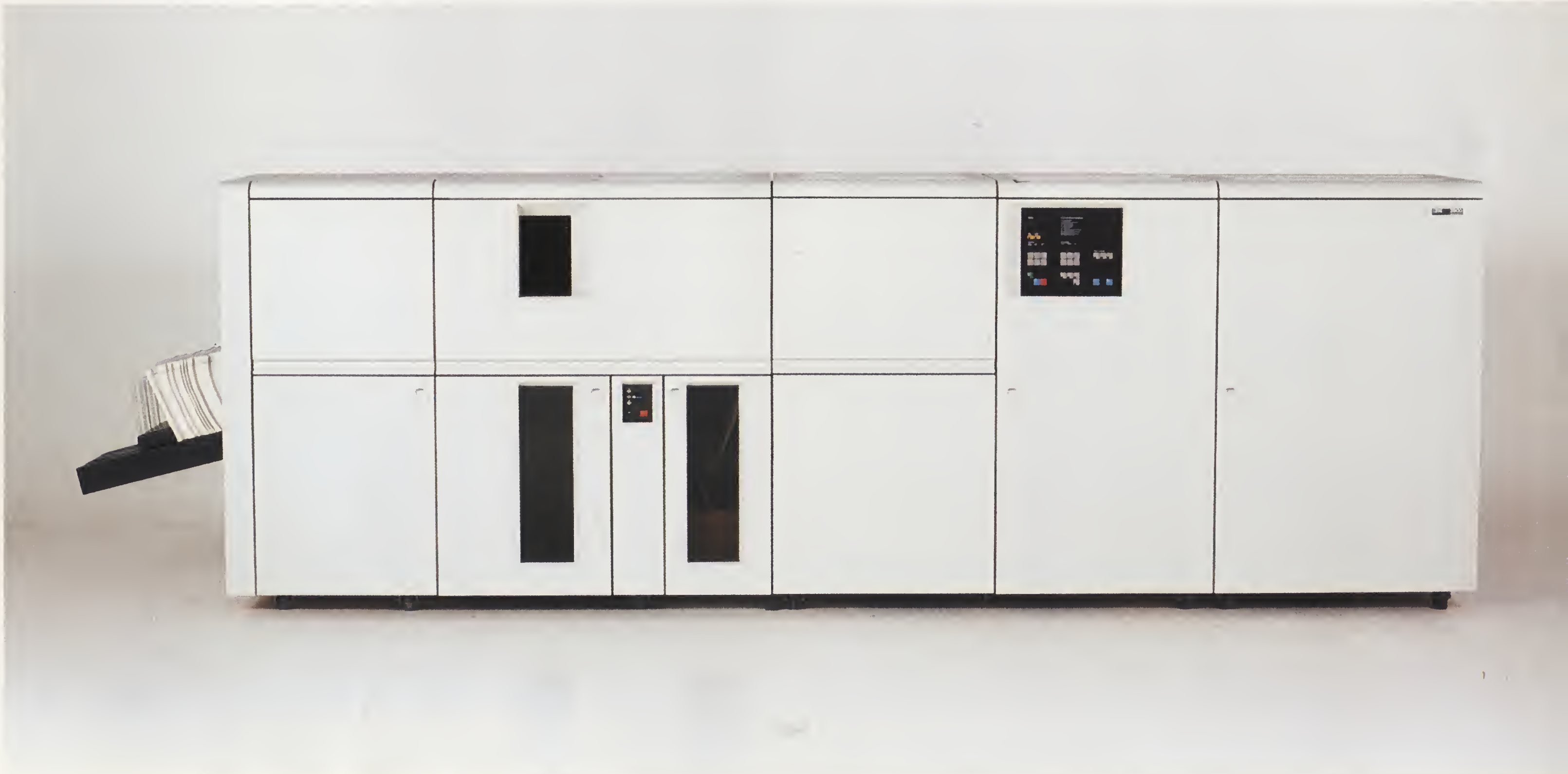
IBM 8809 Magnetic Tape Unit—The 8809 was the first new product to be announced

by the GPD Tucson laboratory, although its development originated at the division's facility in San Jose, California. Unveiled in October 1978, the unit is distinguished from IBM's earlier half-inch tape products by its reel-to-reel drive and its ability to operate at either of two speeds. The 8809 is used with IBM's 4331 Processor and the 8100 Information System.

IBM 3420/3803 Magnetic Tape Subsystem — Users of larger IBM data processing systems generally select one or more models of this subsystem to meet their magnetic tape needs. Depending on the model, the 3420 can record up to 6,250 bytes per inch, and provide data rates of up to 1.25 million characters per second.

IBM 3410/3411 Magnetic Tape Subsystem — This subsystem is most commonly used with small-to-medium sized data processing systems. It consists of a primary tape unit (3410) and a control unit (3411), to which multiple satellite 3410's may be attached. The subsystem's features include compact, low-cost design and seven-or nine-track operation at recording densities of up to 1,600 characters per inch. Resulting data rates range from 2,500 to 80,000 characters per second.

Electronic circuit cards — IBM Tucson assembles and tests all the cards that go into the General Products Division's products. Both manual and sophisticated automated tests are performed to ensure that the cards meet IBM's stringent requirements.



Sunny and dry. If you know nothing else about Tucson, you should know that. The sun shines 85 percent of the time, and the relative humidity averages less than 30 percent. But if you think the words "desert" and "lifeless" are synonymous, you've never seen cactus flowers in bloom, or the fields of poppies that gave the old Butterfield Stage its name.

With a near-perfect climate, it follows that the flow of life in Tucson naturally includes a lot of outdoor activity. Golf and outdoor tennis are year-round activities, and it's entirely possible to celebrate the new year with a dip in your swimming pool on January 1.

While Tucson is justifiably famous for its climate, its colorful history deserves equal billing. Traces of prehistoric peoples dating from 12,000 B.C. have been found in the area, and ancient Indian cultures began to leave their mark 500 years before the birth of Christ.

When the first Spanish explorers came to the valley in about 1535, the local inhabitants called the area "schook-son," or "foot of the dark mountain." *Tucson,* an Anglicized version of the Spanish pronunciation of that ancient Indian name, is thus older than the oldest of the Spanish missions that dot the Southwest. The city's name is a link with its prehistoric past.

More recently Tucson was known as "the last of the wild, wild west." In 1881 Wyatt Earp emerged victorious from the gunfight at the OK Corral in Tombstone, 70 miles to the southeast. Place names, architecture and style of dress echo that era today, and La Fiesta de los Vaqueros (The Festival of the Cowboys) celebrates Tucson's heritage every February. The area abounds in historic sites, abandoned mining camps, and other reminders of that colorful period.

With a population of more than half a million, however, Tucson offers a great deal more than sunshine and history. Live theater, dance and opera are staples of the city's cultural life, thanks to local performing companies. In addition, the Tucson Community Center regularly schedules top stars from the fields of rock, country and pop music, as well as philharmonic orchestra concerts, traveling Broadway productions, national opera and dance companies, and other major events.

For those who enjoy spectator sports, Tucson offers everything from auto racing to tennis tournaments, including PAC-10 college athletics, the Tucson Open golf tournament, and Pacific Coast League baseball. In addition, Tucson is the winter home of the Cleveland Indians.

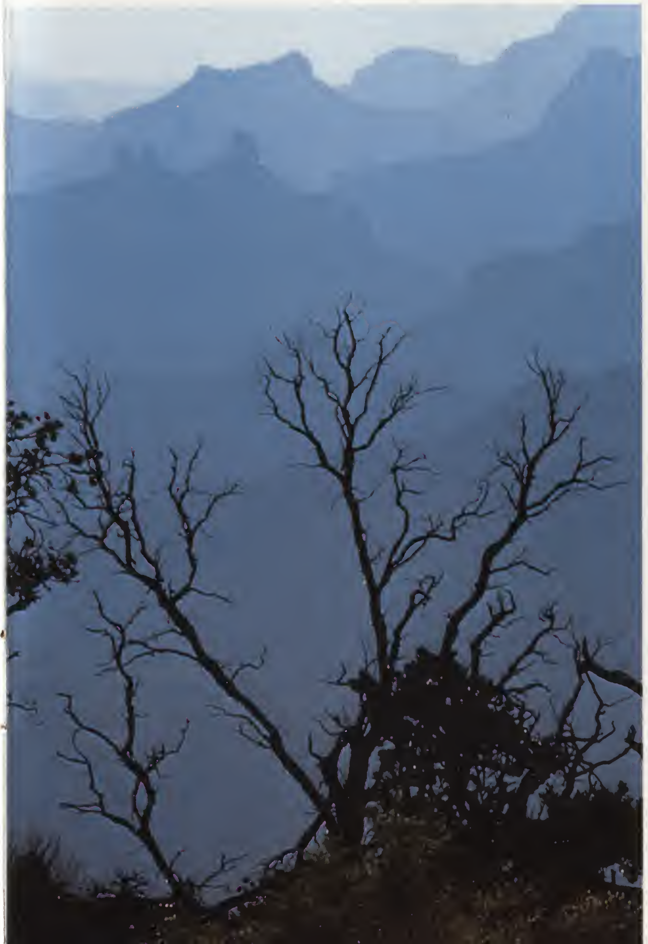
For those who like to be active during their leisure hours, there are 11 public and eight private golf courses in and around Tucson, and more than 150 tennis courts—about half of them lighted. The IBM Club in Tucson has tennis tournaments, swim meets and leagues for baseball, basketball, soccer and racquetball, in addition to its other activities.

There are four downhill-skiing areas in Arizona, one of them an hour's drive from Tucson. Scuba diving is popular at Rocky Point, four hours away on the Gulf of California, so it's possible to snow ski and scuba dive on the same day if you're so inclined.

For hunters, the state offers deer, antelope, elk, bighorn sheep, grouse, javelina, dove, turkey, bear, quail and geese.

If you like to hike and camp, Arizona's climate and scenery make it unbeatable. The Grand Canyon and Monument Valley are two of the state's more spectacular campgrounds, but you don't have to drive to Northern Arizona to enjoy nature. Tucson is surrounded by four mountain ranges—the Catalina, Rincon, Santa Rita and the Tucson mountains. They all offer a variety of trails and breathtaking beauty, and they're all within a short drive from the city. In fact some challenging trails into the Catalina mountains begin almost within the city limits.

With two national parks, 14 national monuments, seven national forests, two national wildlife refuges, 15 state parks, 19 Indian reservations and numerous lakes and streams, Arizona offers a lifetime worth of outdoor activity within its own borders.



Tucson is the home of the University of Arizona and Pima Community College. A wide range of undergraduate and graduate degrees are available from the University of Arizona, including the following.

Business Administration — Master of Business Administration; Master of Accounting; Master of Arts with major in economics; Master of Science with majors in finance, management, management information systems, and marketing.

Doctor of Philosophy with majors in business administration and economics.

Computer Science — Courses include the study of computers, computer systems, computer programming, and related mathematical subjects. The department offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees.

Engineering — Master of Science degrees are offered with majors in a wide range of engineering disciplines, including chemical engineering, electrical engineering, engineering mechanics, industrial engineering, and mechanical engineering.

The Doctor of Philosophy degree is offered with the same majors, with the exception of industrial engineering.

Tuition refund — IBM offers 100% tuition refund for courses taken relating to your IBM career development.

IBM Tucson participates in televised technical classes broadcast live to the site from the University of Arizona. There is also a two-way communication hookup called the Interactive Educational Television System which allows questions to be asked during the lecture.

The pursuit of excellence is encouraged throughout the corporation and graduate level education is a significant part of it.

IBM

If you're an electrical engineer looking for challenge and room to grow, you already know that the data processing industry is the most exciting field for you. Perhaps you also know that IBM offers more opportunity for creative engineers than any other company in the industry. What you may not know, however, is exactly what IBM's electrical engineers do at the company's facility in Tucson.

Electrical engineering is a key profession within IBM Tucson's development lab, test lab, and its manufacturing plant. The development lab creates and develops better ways of storing, retrieving and printing information. Electrical engineers in Tucson help devise the basic concepts that make those improvements possible, and they help develop the technologies that transform those concepts into working machines.

The test lab is an independent organization separate from the development lab. It evaluates IBM Tucson's products for function and performance to determine whether those products adhere to IBM specifications, and to evaluate the adequacy of those specifications. Electrical engineers in the test lab play key roles in providing better, more dependable products for IBM's customers.

Electrical engineers in the manufacturing plant answer the question, "Can this product be manufactured and tested?" and solve problems that stand in the way of an affirmative answer. They help transform laboratory models into production machines that perform for customers according to IBM's exacting specifications.

To accomplish those broadly defined goals, electrical engineers are engaged in a wide range of activities. Following are descriptions of some of them.

Electromagnetic compatibility, acoustic engineering—Data processing equipment emits electromagnetic and acoustic noise, and is often bombarded by such emanations from other sources. Engineers working in this field ensure that emissions from IBM Tucson's products remain within acceptable levels. They also ensure that Tucson's products are not adversely affected by emissions from other sources.

Engineers in this department give design guidance and support to circuit, logic, mechanical, and manufacturing engineers during every phase of product development, test, and manufacture. They use the most up-to-date, state-of-the-art materials, analysis and instrumentation available.

Power systems design engineering—An integral part of every new product design is the power system needed to meet the product's unique requirements. Engineers in this field begin by defining the power requirements of each new system. They are involved with many technology tradeoffs regarding power efficiency, cost, maintainability and other factors which influence the machine architecture.

The power engineer is involved with the product through the entire design, test and manufacturing cycle. Automated design and analysis tools are continuously updated and applied to these design and support tasks.

VLSI design—Engineers and programmers interested in solving a wide variety of problems using leading edge technologies and equipment are needed to design VLSI (very large scale integrated) circuits. The key components of VLSI design are architecture, logic design, circuit design, layout design, and tools development.

The architect analyzes the requirements of the machine under development, selects a technology and develops the framework for the design.

Logic and circuit designers use computer models to simulate the chip logic and circuits as they design them, to verify that the circuit will function according to plan.

Layout designers take a set of circuits and a logic print and interconnect the circuits to form a multi-layered VLSI chip layout using computerized interactive graphic equipment.

Programmers in the tools development group develop software to automate the logic design, circuit design and layout processes for VLSI design.

Design automation engineering—This discipline requires a blend of electrical engineering and computer science skills not often found in one individual. Interested electrical engineers can develop their computer science skills with the help of IBM's many education and training programs.

Computer-aided design (CAD) plays an important part in the design of high technology electronic logic and circuit packaging processes. The engineer combines his or her knowledge of the design process, of programming, and of computer systems to optimize the efficiency of the logic design process.

The design automation engineer evaluates and defines requirements for both hardware and software tools used in design automation, develops new tools as required, integrates them into the total system environment, develops design methodologies involving their use, and provides consultation to end users as required.

Test engineering—Test engineers are IBM's most severe critics, stressing IBM products

in every dimension to ensure top performance for customers. Electrical engineers working in the test lab begin by establishing the test process. They define the test concept, design the test system, perfect it, and generate test procedures. They also work with people in manufacturing and cost control, and become involved with new products as they are developed.

Manufacturing engineering — Manufacturing engineers review engineering product documentation to assure that the product can be manufactured and tested. Of particular concern is the question of whether new technologies can be transferred from the laboratory to the manufacturing line. Each individual part of the machine must meet IBM standards for performance and safety, the machine must be manufacturable at a competitive cost, and it must perform to IBM specifications. Manufacturing engineers see to it that the 10,000th machine performs for the customer at least as well as the development model performed in the laboratory.

IBM

Materials Science—Materials scientists at IBM Tucson may work in any of a number of subspecialties as they create new technologies for storing and printing information. A metallurgist may be involved in thin film depositions, magnetic materials, or evaluation of a metal part. A surface scientist or tribologist may explain wear and lubrication observations based on the physics and chemistry of materials. A polymer engineer may be involved in the selection of engineering plastics for mechanical applications, or an investigation of the effects of processes used to manufacture parts.

Chemical Engineering—Chemical engineers may pursue a specialty in either development or production engineering. In either specialty, there is continual interaction with fellow professionals, and a heavy emphasis on interdisciplinary problem solving in the fields of information storage and retrieval and nonimpact printing.

Opportunities exist for chemical engineers in such areas as:

- Organic coating formulations and processes
- Pigment treatment and dispersion
- Solvent recovery and purification
- Plating and deposition processes
- Materials development and specifications
- Polymer applications development
- Polymer molding
- Laboratory and plant process automation

Chemistry—Chemists at IBM in Tucson work at the frontiers of their discipline to meet the challenges of developing and producing new products.

- Polymer chemists are working in the field of binder and substrate development to produce improved recording media.
- Inorganic chemists are developing improved magnetic pigments.
- Colloid and surface chemists are involved in the field of magnetic pigment dispersions.
- Electrochemists are developing new plating techniques for recording heads.
- Analytical chemists are developing new methods of analysis for major and trace components in materials.

In all their work, chemists have the freedom to work with professionals in other fields to create and improve multicomponent chemical products.

Physics—Work on the frontiers of magnetic storage and nonimpact printing requires an understanding of the fundamentals of the processes and materials employed. Thin films, materials interactions, magnetic and electric fields, lasers, optics, electrophotography, and photolithographic techniques are a few of the technologies employed.

The physicist works with professionals in other fields as well to develop state-of-the-art products. For example, he or she might work with electrical and mechanical engineers in electromagnetic compatibility and acoustic engineering. This group is responsible for ensuring that GPD Tucson's products perform satisfactorily in their intended installations without suffering or causing performance degradation from either electromagnetic or acoustic phenomena.

IBM

Industrial engineering—Industrial engineers at IBM Tucson play a central role in virtually every major decision concerning the manufacturing facility's operations. Industrial engineers must combine both business and technical skills to find the most cost-efficient solutions to problems faced by plant management.

Planning—Human resource planning affects every function and department in the plant. Industrial engineers are responsible for advising plant management on how many people each area should be allocated to most efficiently accomplish its mission. Industrial engineers must be familiar with the needs of every function, and be able to forecast how those needs will be affected by changes elsewhere in the plant.

In a business as dynamic as data processing, space requirements must constantly be adjusted as customer demand for each product increases or decreases, new products are introduced, old products move to new locations, and departments change in size. Industrial engineers determine how much space should be allocated to each department—once again, a decision that requires familiarity with the operation of the entire plant.

Once it's decided how many tape drives, printers, DASDs, Mass Storage Systems and circuit cards should be manufactured in Tucson in a given period, it's up to the industrial engineers to decide exactly how that will be accomplished. No decisions are more central to the operation of the business.

Cost engineering—Equally important is the question "How much will it cost to manufacture each product?" Again, plant management turns to industrial engineers to help provide the answer. Cost estimates for both new and existing products, for the entire Tucson product line, are the responsibility of industrial engineers, along with their counterparts in the development lab.

Manufacturing support—Once the number of people and amount of space necessary to manufacture a product has been determined, it's necessary to design the actual layout of the manufacturing area. Warehousing space and material handling systems also must be planned. All this is the responsibility of industrial engineers.

IBM

Programming/ Computer Science—For programmers and computer scientists, IBM provides an unparalleled opportunity for challenge, excitement and creativity. At GPD Tucson they play important roles in the development lab, the test lab and the manufacturing plant, making possible the operation of one of the most technologically sophisticated facilities in the world.

Following is a description of some of the activities of programmers and computer scientists at IBM Tucson.

Development Programming—Programmers within the development laboratory produce application and device support software and microcode in support of GPD Tucson's storage devices and printer products. They design systems that function in complex IBM systems environments, for example MVS and VS1.

It generally takes six months to a year for a new programmer to acquire the skills to develop new systems using IBM software, techniques and procedures. After an initial education period, the programmer is assigned to a subset of a complex system and is expected to design, develop, test and support the integration and test activities for the project.

The following is a representative list of items a new programmer would be expected to learn and use to be an effective systems developer.

- Development languages: Assembler, PLS
- Development systems: MVS, VM
- Development tools: TSO/SPF, VM/CMS, Script, CLEAR
- IBM System 370 and advanced architecture
- Applications: HSM, DCF, DLF, DBRC
- Systems Development Process

VLSI Design—Engineers and programmers interested in solving a wide variety of problems using leading edge technologies and equipment are needed to design VLSI (very large scale integrated) circuits. The key components of VLSI design are architecture, logic design, circuit design, layout design, and tools development.

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Systems Programming—IBM is one of the world's largest users of its own products, and programmers and computer scientists play vital roles in keeping its systems operating. From secretarial stations to the payroll department to the development laboratory, data processing systems are used to keep GPD Tucson operating efficiently.

Systems programmers plan for, install and maintain complex operating system configurations in both batch and interactive environments. Problem determination and resolution, performance analysis and tuning, and resource management and security are all responsibilities of the systems programmers.

The systems programmer reviews proposed data processing solutions and recommends alternative approaches as appropriate. When the most feasible technical solution has been determined, the systems programmer develops the necessary installation and test plans for the software products that Information Systems provides. When the installation has been completed, the systems programmer uses a number of procedures and tools to maintain the data processing services in an efficient and effective manner.

Applications Development—Applications programmers develop, maintain and enhance programs needed to run the business of GPD Tucson. Their duties include the development of new applications, from the design stage through coding, testing and installation. They also customize programs developed at other IBM locations to fit the application in Tucson.

The group supports the entire laboratory and manufacturing plant by supplying the programming ability to control

manufacturing lines, financial areas, purchasing systems, warehouse inventories, personnel tracking, quality control functions, and any other areas that need programming support.

Applications programmers work very closely with the user groups. They spend time training users of the systems and finding ways to enhance existing systems to fit the constantly changing environment. They devote time and efforts to the computer operations section to be certain the systems they are responsible for are run and/or monitored properly.

Many programming languages and tools are used, including, PL-1, Assembler, JCL, VM, TSO, and CADAM.

IBM

Mechanical Engineering — Mechanical engineers at GPD Tucson help develop, test and manufacture products that define the state of the art in information storage and nonimpact printing. In the development lab, the product test lab and in the manufacturing plant, they work with professionals in a number of disciplines to create new technologies and to make those technologies available in competitive products that meet IBM's standards for reliability, availability and serviceability.

In the pursuit of these goals, engineers become involved in a wide range of activities. Following are descriptions of some of them.

Vibration Analysis — IBM's standards require analysis and control of vibrations to less than a micrometer. Engineers use spectral analysis, transfer functions, mathematical models and computer simulations to analyze and control vibration problems.

Test Engineering — Test engineers are IBM's most critical customers. They design and use test equipment to stress GPD Tucson's products in every dimension to ensure top performance in the customer's office. Among their responsibilities is the performance of engineering analyses of tolerances for interference, interchange and manufacturability.

Machine Design — GPD Tucson's flexible media storage products and nonimpact printers are among the most technologically sophisticated electromagnetic devices in the world. Design, design review, and coordination with toolmakers are integral parts of the mechanical engineer's responsibility in developing a new product.

Applied Mechanics — The mechanical engineer's expertise assures the quality performance of air bearings, spacing controls, paper transporters and the many other critical components of GPD Tucson's products. Typical analysis includes thermal and hygroscopic effects along with fluid dynamics, stress analysis, life estimates, and many sensor-based experiments.

Acoustic Engineering — The engineer's responsibilities are to ensure that IBM's products perform satisfactorily in their intended installations without suffering or causing performance degradation from acoustic phenomena. Design guidance and support is provided to other engineers from the initial concept phase through test verification and product shipment.

Instrumentation — Consistent performance of manufactured parts requires extensive analysis. The mechanical engineer specializing in instrumentation does in-depth studies of tolerances and their associated costs. Standard tools and specialized test equipment, including computer controlled automated testing, assist in the design and analysis of test systems.

Manufacturing — It's not enough to devise new technologies, or design machines that outperform current products. New products must be manufacturable and inspectable. They must perform according to IBM standards of reliability. Mechanical engineers help ensure that those goals are met.

Materials and processes must be selected and tolerances verified. New manufacturing processes must be devised. Tools must be specified and, in some cases, designed. Mechanical engineers help make possible the transfer of a product from the development laboratory to the customer's installation. The success of that transfer ultimately determines the success of GPD Tucson.

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